FOOD SPECTRUM OF THE COMMON INDIAN TOAD *BUFO MELANOSTICTUS* SCHNEIDER[1]

MERCY MATHEW AND M.I. ANDREWS[2]

(*With one text-figure*)

Key words: *Bufo melanostictus*, food, feeding habits

The food and feeding habits of *Bufo melanostictus* in the Kuttanad region of Kerala were studied. Arthropods formed a major food item while insects were the most favoured food of the species. The present study reaffirms that the toad is a useful anuran for controlling pests.

INTRODUCTION

The stomach contents of many anuran species have been examined to determine their role in an ecosystem. Though the food of several anuran species inhabiting temperate regions has been studied extensively (Drake 1914, Berry and Bullock 1962, Berry 1970, Blackith and Speight 1974, Strussman *et al.* 1984, Barrentine 1991, Evans and Lampo 1996, De Bruyn *et al.* 1996), the food and feeding habits of only a few tropical species have been investigated (Wadekar 1963, Isaac and Rege 1975, Nigam 1979, Mohanty-Hejmadi *et al.* 1979, Battish and Sandhu 1988, George and Andrews 1995).

In the Indian subcontinent, the food and feeding habits of toads were studied by some workers (Rangaswami and Channabasavanna 1973, Battish *et al.* 1989, Sreelatha *et al.* 1990). Except for the latter, no detailed work has been done on the food spectrum of *Bufo melanostictus* in Kerala. The present study was, therefore, undertaken to determine the food of *B. melanostictus* in the Kuttanad region of Kerala and its role as a biocontrol agent.

MATERIAL AND METHODS

Stomach content analysis of *B. melanostictus* was carried out from January 1991 to December 1992. A total of 213 toads (80 males and 133 females) were examined. Adult toads were collected at night from paddy fields and habitats in Kuttanad, a natural wetland of Kerala. They were killed immediately and preserved in 10% formalin. The toads were weighed and sexed in the laboratory. The stomach was excised from the toad and weighed. The weight of its contents were recorded separately. The contents were examined under a binocular dissecting microscope, sorted and preserved in 70% alcohol. Food items were identified and the number of individuals of each type were recorded. The correlation between the body weight and weight of gut contents was statistically analysed.

RESULTS

The distribution of stomach contents of *B. melanostictus* (expressed as a percentage of total body weight) with respect to sex and month is shown in Table 1. Female toads were found to consume more food than males except in September, November and December. The females collected in January, May and June were observed to have a higher percentage weight of stomach contents. Table 2 lists the classified food items of *B. melanostictus* and their economic importance. It is evident from the data obtained that the food of *B. melanostictus* consisted of invertebrates of 15 orders (Table 3). The toad mainly fed on arthropods. No vertebrate prey was found. Stomachs of 14 specimens examined were empty. Ant species dominated the diet (56.36%). Termites, though numerically abundant

[1]Accepted January, 2000

[2]Department of Zoology, Mar Thoma College, Tiruvalla 689 103, Kerala, India.

TABLE 1
STOMACH CONTENTS OF *BUFO MELANOSTICTUS* EXPRESSED AS PERCENT OF TOTAL BODY WEIGHT WITH RESPECT TO SEX AND MONTH

Month	Sex	
	Male (%)	Female (%)
January	2.48	6.34
February	3.35	3.81
March	2.3	3.22
April	2.78	3.2
May	6.2	7.62
June	2.63	5.49
July	1.58	2.69
August	1.41	1.77
September	3.65	1.8
October	1.81	3.75
November	2.75	2.29
December	3.6	2.84

(26.11%), were preferred by fewer toads. Coleopterans formed the next largest group (9.62%) (Fig. 1). Orthoptera, Hemiptera, Heteroptera, Diptera, Millipedes, Araneida, molluscs and earthworms were also identified. A substantial amount of plant material was present in several stomachs. Miscellaneous items like sand, gravel, stone, hair, seed and flower bud were also recorded.

It is evident from the data that this toad fed on a variety of insects belonging to 15 families of the order Coleoptera. Phytophagous insect pests like *Anoplogenius* sp., *Gonocephalum* sp., *Diocalandra fruminti*, *Rhynchaenus mangifera*, *Sipalus* sp., *Sternochaetus mangifera*, *Sitophilus oryzae*, *Onthophagus* sp., *Anomala chlorocarpa*, *Autoserica insanabilis*, *Anomala* sp. and *Adoretus* sp. were recovered from the gut of *B. melanostictus*. It also fed on root pests like *Cylas* sp., *Heteronychus lioderes*, *Anomala dussumeiri* and *Melanotus hirticornis*, pests of tuber crops like *Lema* sp. and pests of stored grains like *Aliphitobius piceus* and *Rhizopertha dominica*. Predaceous beetles like *Cicindella* sp., *Termitodiscus* sp. and *Luciola* sp., and other

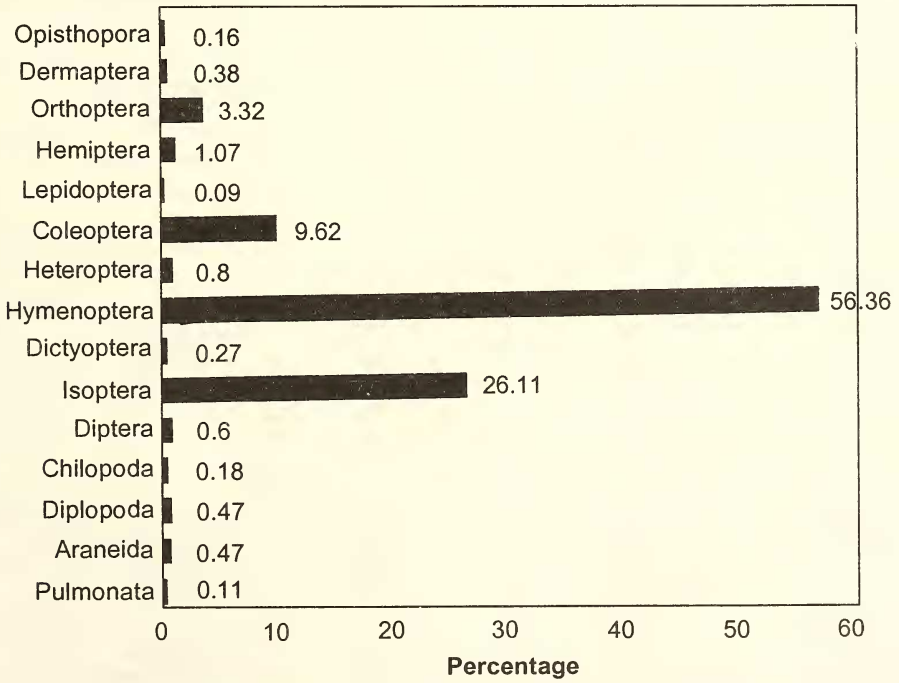

Fig. 1: Annual consumption of food items by *B. melanostictus*

TABLE 2
FOOD SPECTRUM OF *BUFO MELANOSTICTUS*

Classified food item	Number of individuals collected	Number of stomachs examined	Economic importance
Annelida			
Class: Oligochaeta			
Order: Opisthopora			
Family: Megascolecidae			
Megascolex sp.	9	7	
Arthropoda			
Class: Insecta			
Order: Orthoptera			
Family: Tridactylidae	2	2	
Family: Acrididae			
Oxya hyla hyla	35	21	Very harmful to paddy
Oxya chinensis	33	30	Pest of rice and vegetables
Oxya sp.	10	7	Harmful to paddy
Hieroglyphus banian	35	31	Pest of paddy
Family: Gryllidae			
Gymnogryllus sp.	19	11	Omnivorous
Gryllus sp.	25	20	Omnivorous
Family: Gryllotalpidae			
Gryllotalpa sp.	25	18	Household pest, injurious to cultivated plants
Order: Hemiptera			
Family: Cercidae			
Leptocorisa acuta	22	10	Pest of paddy
Family: Delphacidae			
Nilaparvata lugens	30	7	Pest of paddy
Family: Scutelleridae			
Chrysocoris stollii	7	5	Pest of garden plants
Order: Coleoptera			
Family Carabidae			
Anoplogenius sp.	12	7	Paddy pest
Scarites sp.	18	13	Crop pest
Siggona sp.	5	4	Crop pest
Gnathophorus sp.	2	2	
Civina sp.	2	2	
Kareya sp.	2	2	
Family: Tenebrionidae			
Aliphitobius piceus	49	10	Pest of stored grains
Gonocephalum strigatum	36	15	Paddy pest
Gonocephalum sp.	133	38	Paddy pest
Family: Curculionidae			
Rhynchaenus mangiferae	7	5	Mango pest
Diocalandra fruminti	29	12	Foliage feeding
Myllocerus pustulatus	13	5	Pest of vegetable and other plants

TABLE 2 (*contd*)
FOOD SPECTRUM OF *BUFO MELANOSTICTUS*

Classified food item	Number of individuals collected	Number of stomachs examined	Economic importance
Sipalus sp.	3	3	Crop pest
Xanthoprochilus sp.	5	5	
Sternochetus mangifera	3	3	Nut weevil (mango pest)
Sitophilus oryzae	17	10	Stored product pest
Family: Apionidae			
Cylas sp.	4	4	Grubs, pest of tuber crops
Family: Scarabidae			
Hybosorus orientalis	10	6	
Heteronychus liioderes	13	7	General root pest
Popillia sp.	17	5	
Onthophagus sp.	22	9	Crop pest
Serica sp.	3	3	Crop pest
Heliocopris bucephalus	5	3	
Anomala dussumeiri	12	5	Larval forms damage roots of paddy and cereals
Anomala chlorocarpa	12	4	Pest of cashew
Autoserica insanabilis	3	3	Pest of cashew
Family: Elateridae			
Melanotus hirticornis	2	2	Larva feed on roots of plants and pest of stored food grains
Heteroderis sp.	2	2	
Attica sp.	1	1	
Family: Chrysomelidae			
Lema sp.	6	6	Pest of tuber crops
Family: Bostrichidae			
Rhizopertha dominica	18	11	Serious pest of stored grains
Family: Cerambycidae	7	7	
Family: Passalidae			
Ophrigonius sp.	15	7	
Family: Cicindellidae			
Cicindella sp.	13	8	Predator
Family: Staphylinidae			
Termitodiscus sp.	10	5	Predator
Family: Rutelidae			
Anomala sp.	4	4	
Adoretus sp.	7	5	Pest of garden plants
Family: Dasicillidae	3	3	
Family: Lampyridae			
Luciola sp.	3	3	Predator
Order: Heteroptera			
Family: Pentatomidae			
Scotinophora sp.	37	20	Pest of rice
Scotinophora bispinosa	7	7	Paddy pest

TABLE 2 (*contd*)
FOOD SPECTRUM OF *BUFO MELANOSTICTUS*

Classified food item	Number of individuals collected	Number of stomachs examined	Economic importance
Order: Hymenoptera			
Family: Formicidae			
Pheidologeton affinis	44	11	
Pheidologeton sp.	45	20	Household pest
Oecophylla smaragdina	81	17	Household pest
Camponotus compressus	1319	50	Nuisance to trees
Camponotus sp.	1324	70	Household pest
Diacamma sculptum	30	10	
Diacamma vagans	9	7	nuisance to trees
Megachila sp.	225	70	
Solenopsis geminata	13	7	Pest of vegetable seedlings
Family: Mutillidae			
Mutilla sp.	4	4	
Order: Dermaptera			
Family: Forficulidae			
Forficula sp.	19	18	
Order: Lepidoptera			
Caterpillar	5	5	
Order: Dictyoptera			
Family: Blattidae			
Periplaneta americana	9	9	Household pest
Family: Blatellidae			
Blatella germanica	6	6	Household pest
Order: Isoptera			
Termite	1433	14	Household pest
Order: Diptera			
Family: Culicidae			
Anopheles sp.	24	18	Household pest - vector
Family: Muscidae			
Musca sp.	10	10	Household pest - vector
Class: Myriapoda			
Order: Chilopoda			
Family: Scolopendridae			
Scolopendra sp.	10	10	
Order: Diplopoda			
Family: Julidae	26	23	
Class: Arachnida			
Order: Araneida			
Family: Lycosidae			
Paradossa songossa	12	11	Biological control agent
Lycosa sp.	14	13	Biological control agent
Mollusca			
Cryptozona sp.	6	6	

coleopterans like *Scarites* sp., *Siggona* sp., *Civina* sp., *Kareya* sp. *Gonocephalum* sp., *Gonocephalum strigatum, Myllocerus pustulatus*, *Xanthoprochilus* sp., *Hybosorus orientalis*, *Serica* sp., *Heteroderis* sp., *Attica* sp., *Ophrigonius* sp. were also obtained from the gut content (Table 2).

Among the heteropterans, serious rice pests like *Scotinophora bispinosa* and another unidentified species of the same genus were found in the food contents of *B. melanostictus* (Table 2). Hymenopterans were well represented in the food contents. Among them, *Pheidologeton affinis*, *Oecophylla smaragdina* (household pest), *Camponotus compressus*, *Camponotus* sp., *Diacamma vagans*, *Megachila* sp., (tree pests) and *Solenopsis geminata* (vegetable seedling pest) constituted the major portion. A few ant parasites, genus *Mutilla* (Mutillidae) were also found.

The data obtained was statistically analysed and a strong positive correlation was found between body weight and gut weight, and between body weight and gut content weight. (Table 4).

Discussion

The present study reveals that *B. melanostictus* feeds on a wide range of organisms. The food of this toad consists of invertebrates; no vertebrate prey were found. The toad's selection of these organisms is a chance factor. The representation of several orders and families of invertebrates from diverse habits like terrestrial, aquatic and agro-ecosystems showed the toad's affinity to them. Feeding is evidently unselective in *B. melanostictus*, as animals with noxious protective and offensive mechanisms like centipedes, millipedes and spiders are frequently taken. Further, this toad is primarily insectivorous. No cannibalism was observed. Toads, however, are reported to be carnivorous and cannibalistic by Noble (1918) and Sreelatha *et al.* (1990).

The food consumption of the toad is high in May-June and low in July-August. The high food consumption in May-June is because of greater reproductive activity in the monsoon season. The decline in the feeding rate in July-August can be attributed to the low availability of terrestrial insects during the monsoon.

The food spectrum obtained in the present study indicates that arthropods form the bulk of the diet of *B. melanostictus*. Among them, insects appear to be the most favoured. In the present study, Hymenopteran ants of family Formicidae were dominant in the diet of the toad, substantiating the works of Weber (1938) in *B. marinus*, Forge and Barbault (1980) in *B. pentoni*, Battish *et al.* (1989) in *B. stomaticus*, and Evans and Lampo (1996) in *B. marinus*.

It has been reported that, in terms of biomass, coleopterans were predominant in the food of *B. melanostictus* (Berry and Bullock 1962) and *B. stomaticus* (Battish *et al.* 1989). The consumption of large numbers of Coleoptera by *Rana tigerina* (=*Hoplobatrachus tigrinus*) during the pre-breeding period has been noted by Khan (1973). As is clear from the present study, *B. melanostictus* mainly feeds on terrestrial insects. Similar observation was made by Berry and Bullock (1962). This can be correlated with the prey availability in the toad's habitat.

The present study shows that the seasonal variation in the food of *B. melanostictus* may be due to a seasonal change in the availability of prey. Similar observations were made by Brooks (1959), Berry (1965), Khan (1973) and Battish *et al.* (1989). According to Jenson and Klimstra (1966), Hedeen (1970) and Nigam (1979), anurans are opportunistic feeders. The more frequent occurrence of toads in vegetable gardens and orchards is due to the easy availability of prey. A correlation was also found between the abundance of toads and the ground

TABLE 3

PERCENTAGE OF FOOD ITEMS RECOVERED FROM STOMACHS OF *BUFO MELANOSTICTUS* FROM JANUARY 1991 TO DECEMBER 1992

Animal Groups	Months											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Opisthopora	0.41				0.08	0.19	1.71	1.98		0.18		
Dermaptera			0.91	2.22	0.08	0.39		3.96	0.09	0.18	0.81	1.25
Orthoptera	7.88	5.58	3.35	21.48	1.60	2.90	13.68	11.88	0.96	1.56	2.42	10.0
Hemiptera		5.58	4.27		0.15		0.85	0.99	1.22	1.28	0.81	
Lepidoptera		0.47	0.61		0.08							0.63
Coleoptera	13.69	22.79	10.98	49.63	8.02	14.12	49.57	15.84	1.04	2.02	19.35	20.63
Heteroptera		16.74	0.30			0.58	2.56	0.99				
Hymenoptera	65.98	37.21	65.55	21.48	12.76	40.81	18.80	5.94	94.70	92.12	33.06	43.13
Dictyoptera	0.83			0.74	0.23		0.85				3.23	2. 50
Isoptera	8.30	8.84	11.89		75.17	40.23		47.52	1.74	2.11	35.48	17.50
Diptera	1.66	0.47	0.61	3.7 0	0.92	0.19	0.85	2.97	0.09	0.09	0.81	0. 63
Chilopoda						0.19	4.27			0.18	0.81	0.63
Diplopoda	0.41	0.47	0.30		0.08		5.98	7.92	0.17		2.42	1.25
Araneida	0.41	1.86	0.91	0.74	0.76	0.39	0.85			0.27		0.63
Pulmonata	0.41		0.30		0.08						0.81	1.25

TABLE 4
CORRELATION METRICES OF FEEDING ACTIVITY OF *BUFO MELANOSTICTUS*

Correlation between	Females	Males
Body wt. vs Gut wt.	0.85**	0.68**
Body wt. vs Gut content wt.	0.61**	0.45**
Gut wt. vs Gut content wt.	0.92**	0.68**

** Significant for $p < 0.01$

fauna. Strussmann *et al.* (1984) noted that although *B. marinus* ate most prey items in proportion to their abundance, positive selection was shown for ants and termites. In the present study, the dietary differences found between habitats may simply reflect the availability of prey.

The stones, leaves and other debris present in the gut of *B. melanostictus* might have been ingested incidentally with the prey. The presence of stones and vegetable matter in the gut of anurans has been reported earlier (Berry and Bullock 1962, Berry 1965, Battish *et al.* 1989, Sreelatha *et al.* 1990, George and Andrews 1995, Evans and Lampo 1996). Possibly, the stones and plant matter help to crush food items such as beetle carapaces in the stomach. Other objects like grain, seed and flower bud are probably mistaken for food.

The present study reaffirms that *B. melanostictus* is a natural predator of various insect pests, especially some serious crop pests. Though toads are known opportunistic feeders, their feeding on several phytophagous insect pests indicates their usefulness as biological control agents. This has been stressed by several earlier workers (Gadow 1901, Kadam and Patel 1960, Stiles *et al.* 1969, Fellow 1969). It has been reported that *R. tigerina* (=*Hoplobatrachus tigrinus*) (Abdulali 1985), *B. stomaticus* (Battish *et al.* 1989), *B. melanostictus* (Sreelatha *et al.* 1990), *R. limnocharis* (=*Limnonectes limnocharis*) (Sally *et al.* 1992) and *R. hexadactyla* (=*Euphlyctis hexadactylus*) (George and Andrews, 1995) are significant in controlling agricultural pests. *B. melanostictus* feeds on insects, ants and spiders, some of which are beneficial. This toad may be considered useful for the control of pests and other harmful insects, playing an important role in the economy of nature.

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